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Vestibular-Visual Interactions in Flight Simulators

PRINCIPAL INVESTIGATOR: BRANT CLARK



FINAL REPORT

NASA Grant No. NGL 05-046-002

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San Jose State University

SAN JOSE STATE UNIVERSITY, SAN JOSE, CALIFORNIA 95192

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VESTIBULAR-VISUAL INTERACTIONS IN FLIGHT SIMULATORS¹

Final Report on NASA Grant No. NGL 05-046-002

September 1, 1967 to September 30, 1977

Project Director: Brant Clark

San Jose State University
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San Jose, California 95192

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This communication is the final report for NASA-Ames Research Center Grant No. NGL 05-046-002 to San Jose State University. It outlines the work undertaken from September 1, 1967 to September 30, 1977. From its inception, this project was conceived as a collaborative effort between faculty and students at San Jose State University and research scientists in the Life Sciences Research Laboratory at Ames Research Center. However, practically all of the experimental work was carried out at the Laboratory using the Ames Research Center's extensive computer and simulator facilities. This collaborative undertaking has served two major functions. In the first place it has supported a series of specific research projects proposed by the project director and a number of ongoing research projects being conducted in the Laboratory. Secondly, it has made a major contribution to the scientific development of a large number of San Jose State University students, primarily in the psychology department. Furthermore, the grant has resulted in a number of useful interactions between the faculty at the University and the research scientists in the Laboratory.

Research Projects

The research under this grant began as a series of psychophysical experiments concerned with vestibular function per se and specifically investigated man's sensitivity to rotary acceleration. This has resulted in thresholds obtained both in darkness and with a fixed visual reference on the largest group of men now available, and data are

available for both pilots and nonpilots. Data have also been collected on other psychophysical functions of the semicircular canals and such topics as the effects of rotary acceleration on tracking performance and monitoring type tasks. However, with succeeding years the objectives of the grant were broadened substantially to include vestibular-visual interactions in flight simulators and neurophysiological experiments dealing with the vestibular functions of animals. More recently the objectives of the grant have been broadened still further to include the study of the effects of other sensory systems in flight simulators and certain flight management investigations of concern in man-vehicle system interactions. Consequently, the tenth and final annual report summarized not only work on vestibular processes but also included studies of such diverse problems as: (1) the control of the signs and symptoms of motion sickness by biofeedback and autogenic training, (2) visual processes in simulated cockpit displays including Head-Up Displays, (3) auditory cue utilization in simulators, and (4) selected flight management problems including evaluation of work load and the use of synthetic speech callouts during the landing phase of simulated flight.

As a result of this broadening of the purposes of the grant, the experimental work conducted does not fall readily into a single, systematic investigation of a limited field. Moreover, the specific findings have been summarized in the 10 annual reports. Consequently, this report will simply bring together all of this work on man-vehicle interactions in a complete reference list of these contributions to aviation and space science. These reports have been arbitrarily

classified into three categories: (1) published papers, (2) papers read at professional meetings, and (3) completed masters theses at the University. It should be noted that the same experimental data are sometimes repeated in more than one of these categories. This reference list is to be found in Appendix A of this report.

Collaborative work between the University and Ames Research Center

The grant has also served as a vehicle for extensive interaction between the University and the Center. The extensive collaboration involved in the research effort can be shown in part by the number of University faculty members and the number of Ames research scientists who have taken part in the work which has culminated in the research reports listed in Appendix A. During the tenure of the grant, in addition to the project director, nine faculty members in the psychology department have been active on one or more thesis committees and several others have served in various advisory capacities in connection with the research work the student research assistants have carried out under the grant. These faculty members are listed in Appendix B.

Several research scientists at Ames Research Center have also contributed in a major way to the scientific training of the student research assistants through the students' work on the various research projects. The Ames research scientists who have worked most closely with the research assistants are listed in Appendix B, but many other members of the Ames staff have made important contributions to the work of the research assistants. Both the faculty and the students have also benefitted from contacts with visiting scientists at the Center, and

indeed, several of the students have had the opportunity to work for a period with some of the visiting workers.

The grant has made it possible for a large number of graduate and a few undergraduate students to profit by experience in the Laboratory. A total of 62 students have received support by the grant and 55 have worked as research assistants for extended periods (typically during an academic year) in the Life Sciences Research Laboratory. This work has made a major contribution to their scientific development and has served as a valuable supplement to their formal academic work on the campus. As evidence of this, 26 have completed masters theses based on work conducted in the Laboratory, and ten additional theses are in progress. Some 63 experimental reports have a student as the sole or as a joint author. Of the students who have worked on the grant, 23 have been accepted in graduate programs at other universities leading to a doctorate while 9 have already earned doctorates. Some additional details regarding the activities of these students are listed in Appendix C. Altogether the opportunity to have experience in a working research laboratory has been an invaluable contribution to the scientific training of these very able research assistants.

APPENDIX A

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APPENDIX B

San Jose State University
Faculty Members who have
advised Research Assistants.

Research Scientists at
Ames Research Center with
whom the Research Assistants
have worked.

Clark, Brant

Fox, Robert

Ginsberg, Rose

Goodwin, Dwight

Hicks, Robert

Minium, Edward

Rabedeau, Ronald

Richardson, Harold

Sawrey, James

Witte, Robert

Baty, Daniel

Coler, Clayton

Daunton, Nancy

Haines, Richard

Huff, Edward

Nagel, David

Palmer, Everett

Stewart, John

Tanner, Trieve

Wempe, Thomas

APPENDIX C

ACTIVITIES OF STUDENTS WHO HAVE WORKED ON THE GRANT

1. Total number of students who have been supported by the grant.	52
2. Number of research assistants.	55
3. Number of completed masters theses based on work in the Laboratory.	26
4. Number of theses in progress in the Laboratory.	19
5. Number of experimental reports with a student as the sole author.	28
6. Number of experimental reports with a student as a joint author.	35
7. Number of these students accepted in Ph.D programs.	21
8. Number of Ph.Ds completed.	8
9. Number of M.D. degrees completed.	1
10. Number of students in a DVM program.	1
11. Number of former students known to be working as professional psychologists.	17